High transmission through waveguide bends by use of a circular photonic crystal

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Photonic Crystals (PCs) have received considerable attention owing to their abilities for the realization of ultra-compact and multi-functional devices for high-density photonic integrated circuits (PICs). It is necessary to introduce waveguide bends for the high-density, which become one of the main contributions in not only generating loss but also limiting the bandwidth of the transmitted signal. Various alternative approaches for bend designs have been theoretically or experimentally studied [1-3].

In this paper, we design PC waveguide bends by use of a matched circular photonic crystal (CPC) and demonstrate it to improve the transmission properties of waveguide bends in a 2D photonic crystal. The 2D photonic crystal considered here is a triangular lattice of air holes in a dielectric media. A circular photonic crystal connects the 2D PC waveguides instead of conventional PC waveguide bends. The structure of the CPC follows the rule that the distance between holes must be constant on each concentric circle. The air holes are arranged in the form of concentric circles with radial distance d. The positions of the air holes for a sixfold symmetric CPC are given by

$$x = dN\sin(2m\pi/6N),\ y = dN\cos(2m\pi/6N)$$

where N, d and m are the number of concentric circles, the radial distance, and an integer from 1 to 6N, respectively.

We have studied two types (Y and U type) of PC waveguide bends utilizing CPCs. It has been shown, compared with conventional PC waveguide bends, that the bend losses of our designs are much smaller. The bend losses are less than 1dB over a relative 8% bandwidth. Further study for optimizations are still in the progress. Theoretically, an arbitrary bent angle of a line-defect waveguide can be designed by use of the CPC.

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